



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p><b>(54) Title:</b> FLEXIBLE TUBE WITH CIRCULAR GROOVES OF VARYING WIDTH AND DEPTH</p> <p><b>(57) Abstract</b></p> <p>A flexible lumen (10, 10', 10'', 110, 210) made from a solid, relatively rigid tubing (12, 12', 12'', 112, 212) that is made flexible by cutting a series of grooves (14, 14', 14'', 114, 214) of varying width and depth through the side of the tubing (12, 12', 12'', 112, 212).</p>			

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## FLEXIBLE TUBE WITH CIRCULAR GROOVES OF VARYING WIDTH AND DEPTH

Background of the Invention

This invention relates generally to the field of catheters and more particularly to steerable catheters.

Medical catheters generally comprise flexible tubular members that may be inserted into the body through an incision. Some of these catheters may be twisted or steered by an internal guidewire. See, for example, U.S. Patent Nos. 4,921,482, 4,998,916, 5,037,391, 5,108,368, 5,203,772, 5,308,324, 5,372,587 and 5,378,234 (Hammerslag, et al.), U.S. Patent No. 5,217,465 (Steppe), U.S. Patent Nos. 5,242,449 and 5,364,405 (Zaleski) and U.S. Patent No. 5,084,012 (Kelman), the entire contents of which are incorporated herein by reference.

Prior steerable catheters generally use a helical coil made of metal or plastic. The coil either surrounds flexible plastic tubing or the coil is coated with an elastomer to seal the coil fluid tight. The coil is rigid enough to resist collapse but flexible enough to be steered. Coils of this type, however, are difficult to bend at large angles without causing permanent deformation of the coil, and it can be difficult and relatively expensive to manufacture a coil of variable spring constant.

Accordingly, a need continues for a flexible catheter coil that is easy and inexpensive to manufacture and that can be bent at large angles without permanent deformation.

Brief Summary of the Invention

The present invention improves upon the prior art by providing a flexible lumen made from a solid, relatively rigid tubing that is made flexible by cutting a series of grooves of varying width and depth through the side of the tubing.

Accordingly, one objective of the present invention is to provide a flexible catheter lumen that is relatively easy and inexpensive to manufacture.

Another objective of the present invention is to provide a flexible catheter lumen having good torsional stability.

These and other advantages and objectives of the present invention will become apparent from the detailed description and claims that follow.

#### Brief Description of the Drawing

FIG. 1 is a perspective view of the first embodiment of the lumen of the present invention.

FIG. 2 is a side elevational view of the first embodiment of the lumen of the present invention.

FIG. 3 is a cross-sectional view of the first embodiment of the lumen of the present invention taken along line 3-3 in FIG. 2.

FIG. 4 is a side elevational view of the second embodiment of the lumen of the present invention.

FIG. 5 is a side elevational view of the third embodiment of the lumen of the present invention.

FIG. 6 is a front elevational view of the fourth embodiment of the lumen of the present invention.

FIG. 7 is a front elevational view of the fourth embodiment of the lumen of the present invention.

FIG. 8 is a cross-sectional view of the fourth embodiment of the lumen of the present invention taken along line 8-8 in FIG. 7.

FIG. 9 is a front elevational view of the fifth embodiment of the lumen of the present invention.

#### Detailed Description of the Invention

As best seen in FIGS. 1, 2 and 3, lumen 10 of the present invention generally consists of relatively rigid tube 12 into which a series of grooves 14 are cut, leaving a series of bands 16 held together by spine 18. As seen in FIGS. 4 and 5, grooves 14' and 14" can be of varying width and depth to effect the desired flexibility of lumens 10' and 10", respectively. Grooves 14, 14' or 14" may be parallel, or cut at any suitable angle. Tubes 12, 12' and 12" may be made from a variety of suitable materials such as plastic,

stainless steel or titanium and may be of any suitable thickness, varying or constant inside diameter or outside diameter.

Alternatively, as best seen in FIGS. 6, 7 and 8, lumen 110 can consist of tubing length 112 into which a series of opposing grooves 114 and 115 have been cut, leaving a series of semicircular bands 116 held together by a plurality of spines 118. The use of a plurality of spines 118 increases the torsional rigidity of lumen 110.

Lumens 10, 10', 10" and 110 may be made as a separate piece, as illustrated in FIGS. 1-8 or, as illustrated in FIG. 9, lumen 210 may be formed on the end of a relatively long tube 212. Such a structure eliminates the need to attach and seal lumen 210 to the end of a separate aspiration tube (not shown).

In use, lumens 10, 10', 10", 110 and 210 are sealed fluid tight by methods well-known in the art. The mechanism used to steer lumens 10, 10', 10", 110 and 210 are also well-known in the art. One preferred method is the use of one or more push/pull wires 20, 20', 20", 120 or 220. The operation of push/pull wires 20, 20', 20", 120 or 220 is fully disclosed in U.S. Patent Nos. 5,217,465 (Steppe) and 5,378,234 (Hammerslag, et al.) and is incorporated herein by reference.

This description is given for purposes of illustration and explanation. It will be apparent to those skilled in the relevant art that changes and modifications may be made to the invention described above without departing from its scope or spirit.

I claim:

1. A flexible lumen, comprising:
  - 2) a tubing;
  - 3) a plurality of grooves cut into the tubing forming at least one spine; and
  - 4) a plurality of bands held together by the spine.
1. 2. The lumen of claim 1 wherein the grooves have varying width and depth.
1. 3. The lumen of claim 1 wherein the plurality of grooves form two spines.
1. 4. The lumen of claim 1 further comprising at least one push/pull wire.
1. 5. The lumen of claim 1 wherein the grooves are parallel.
1. 6. A flexible lumen, comprising:
  - 2) a length of tubing;
  - 3) a plurality of parallel grooves of varying width and depth cut into the length of tubing forming at least one spine; and
  - 5) a plurality of bands held together by the spine.
1. 7. The lumen of claim 6 wherein the plurality of grooves form two spines.
1. 8. The lumen of claim 6 further comprising at least one push/pull wire.

1 / 4

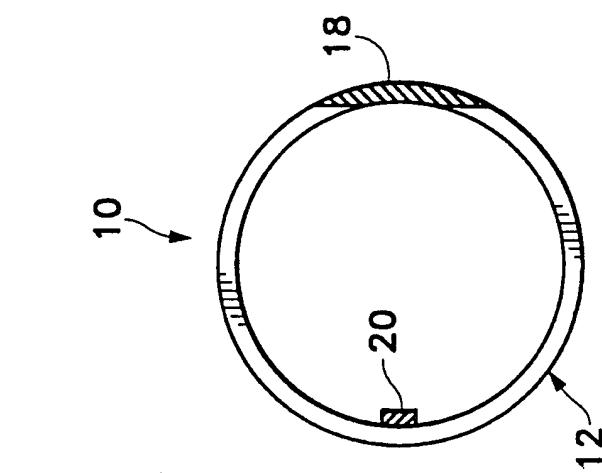


FIG. 3

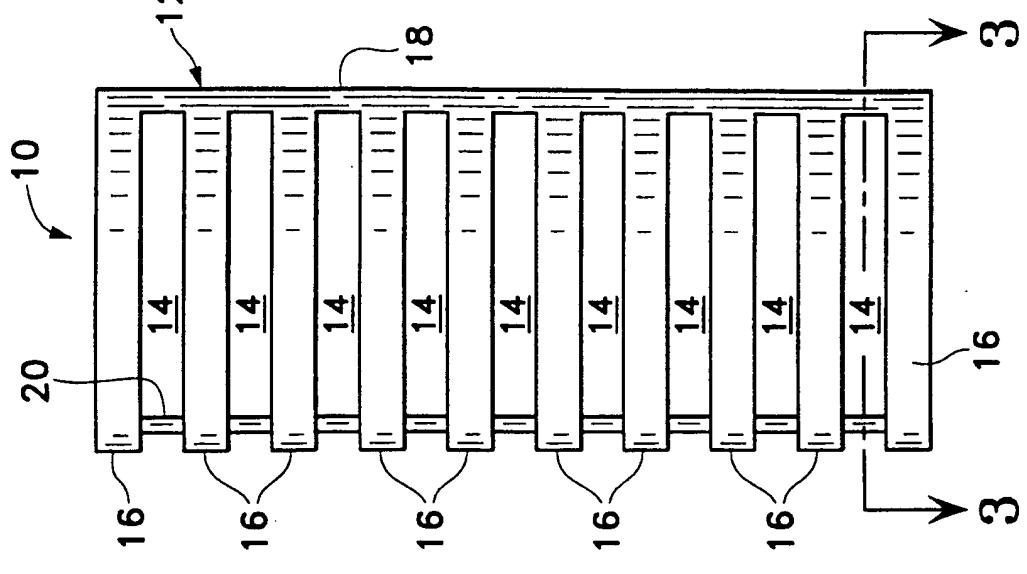


FIG. 2

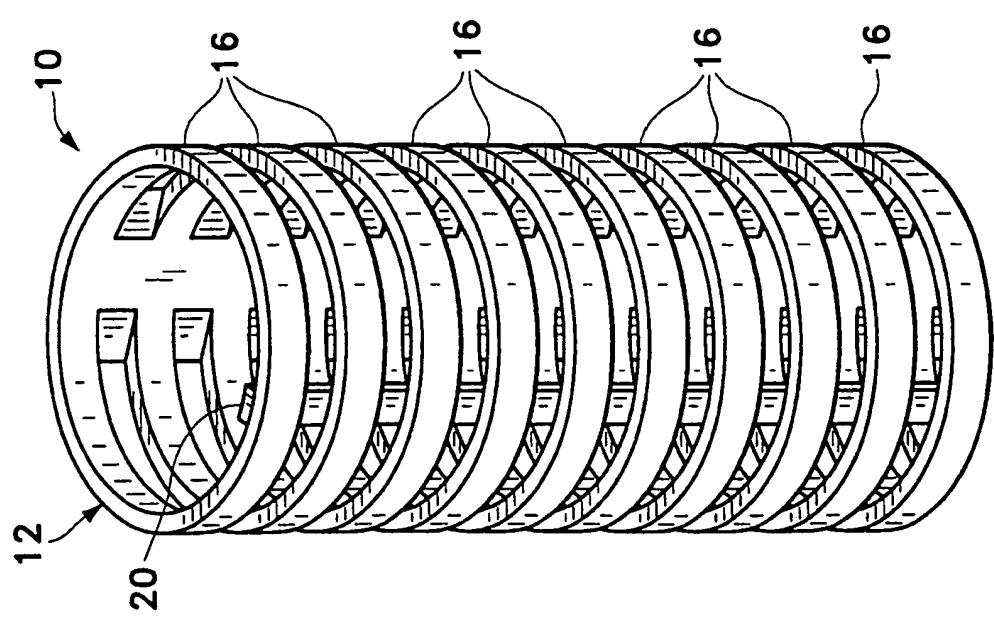


FIG. 1

2/4

FIG. 5

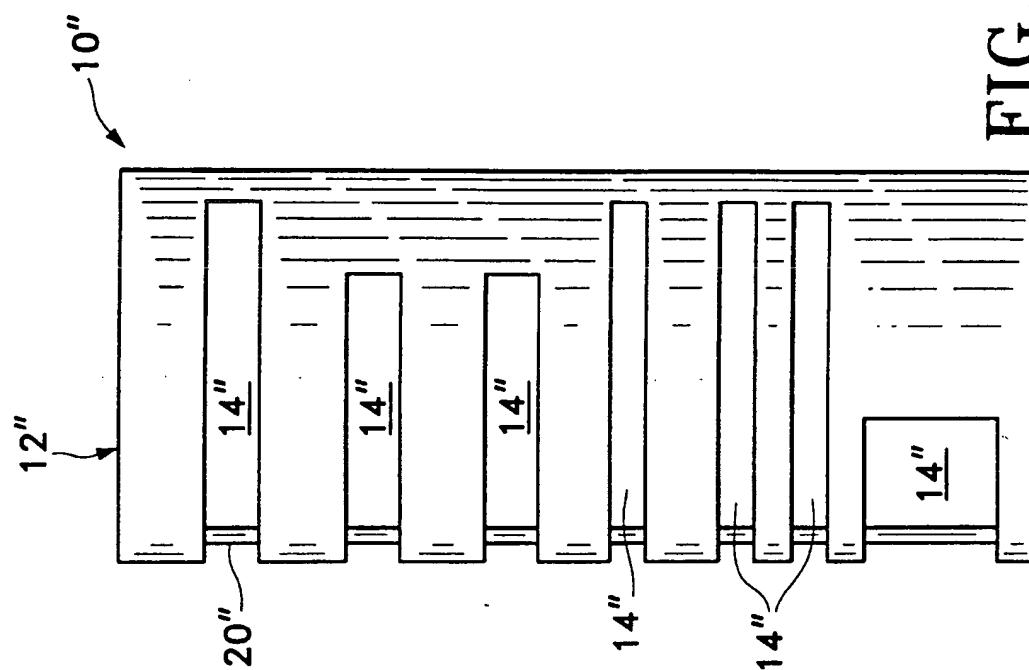
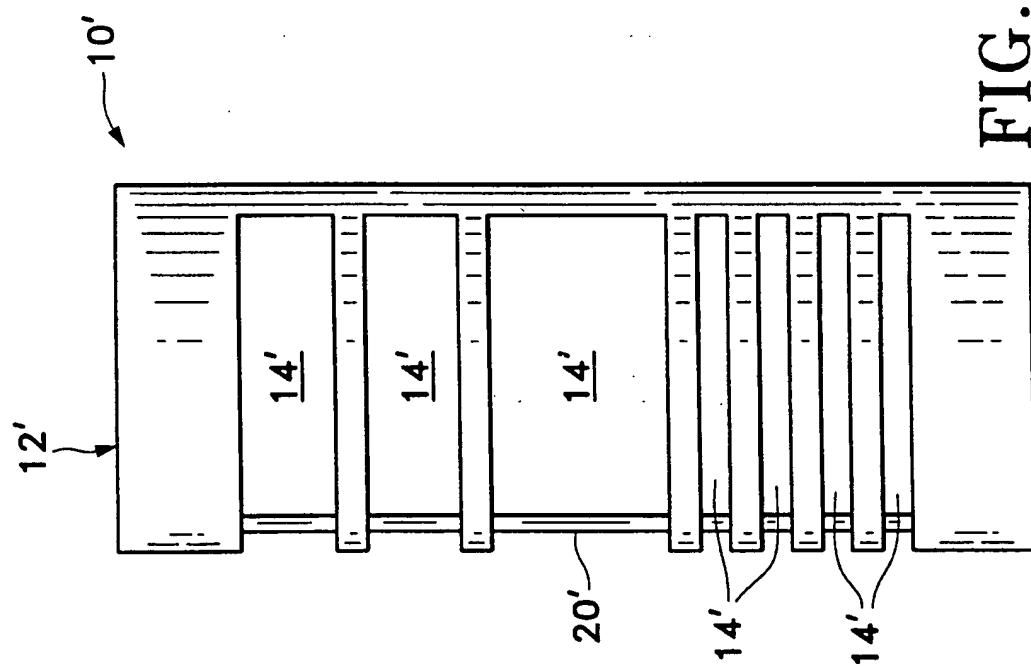
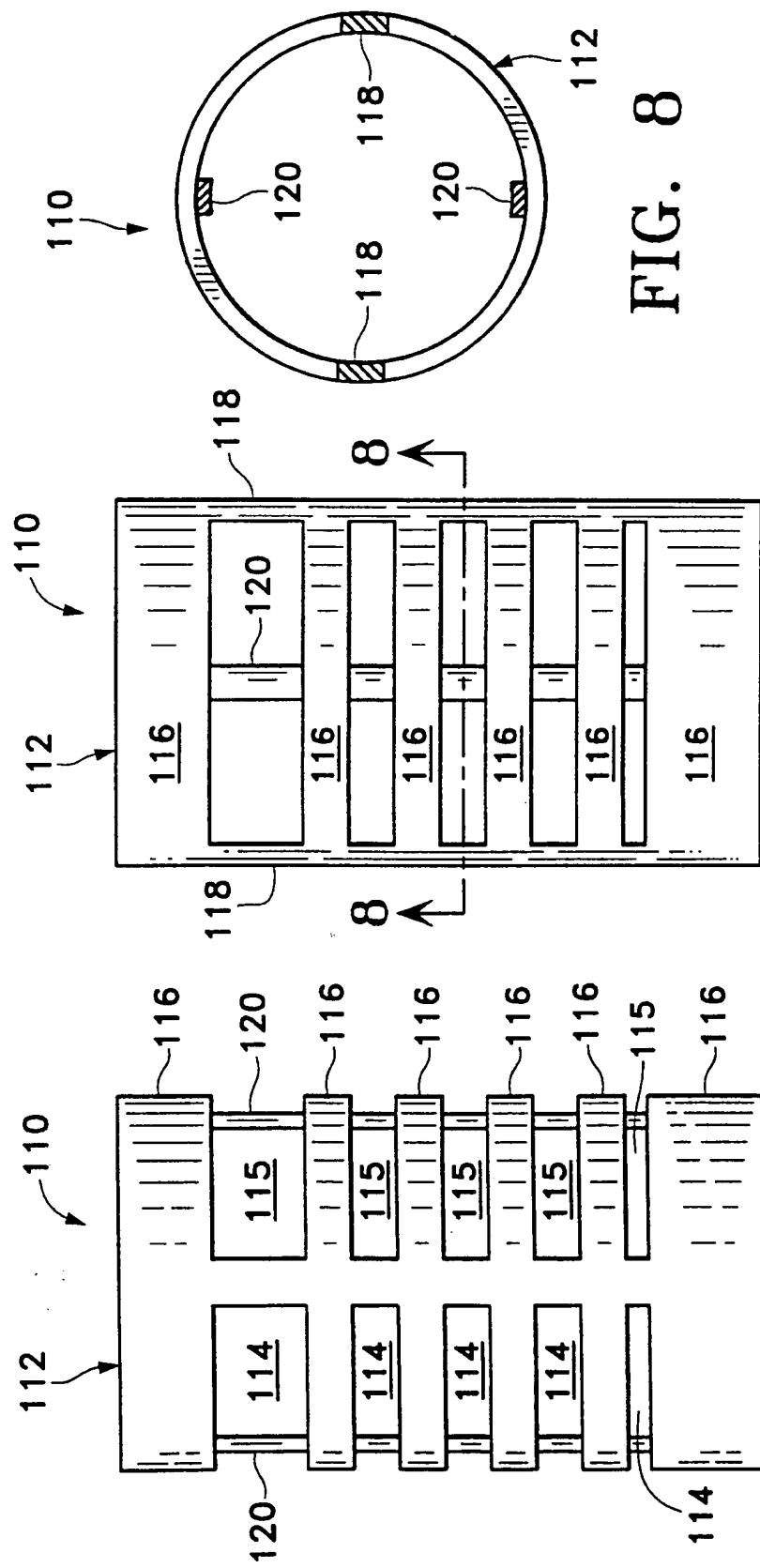


FIG. 4



3/4



4/4

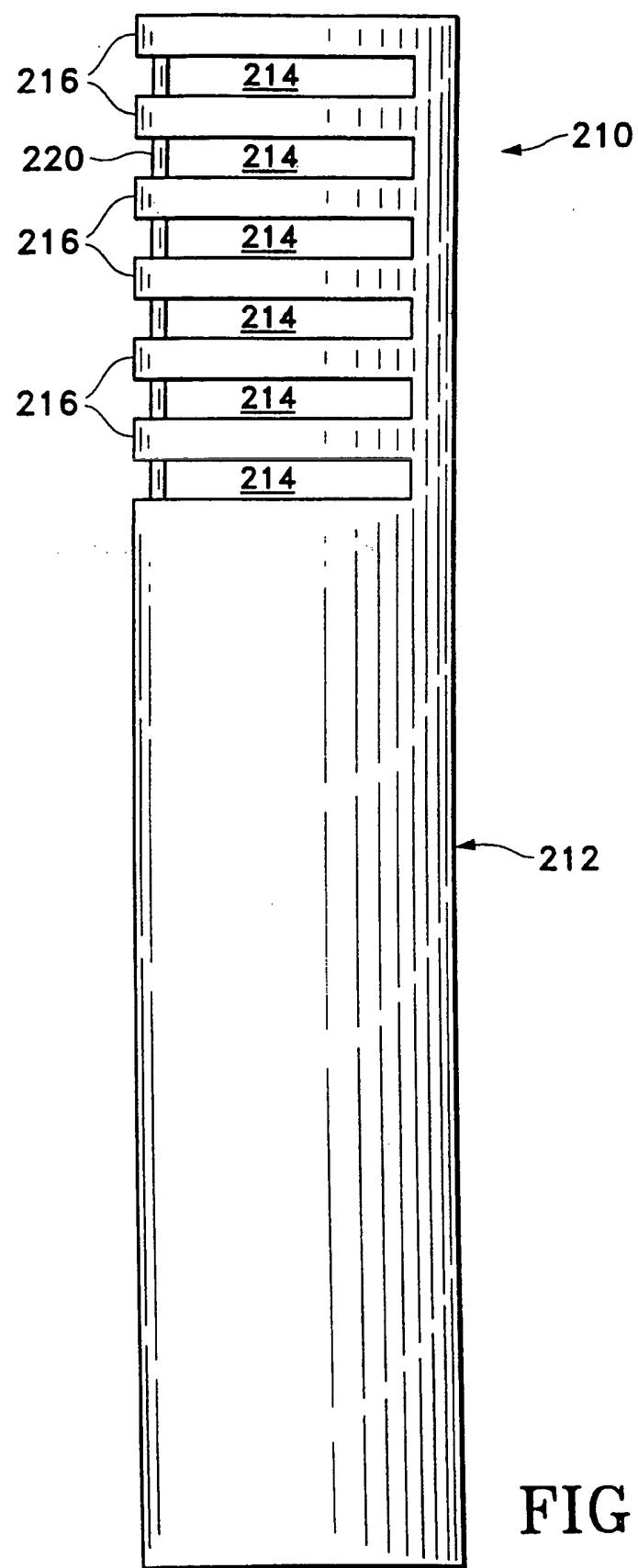


FIG. 9

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/16100

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 6 A61M25/00

According to International Patent Classification(IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 381 782 A (DELARAMA ET AL) 17 January 1995	1,3-5
Y	see column 7, line 4 - column 9, line 56; figures 1-5	2,6-8
X	EP 0 778 039 A (SARCOS INC) 11 June 1997	1
Y	see column 2, line 57 - column 3, line 25 see column 4, line 26 - column 5, line 13; figures 1,4,5	2,6-8
X	FR 2 713 492 A (MICROFIL IND SA) 16 June 1995	1,3-5
A	see page 1, line 5 - line 17 see page 6, line 33 - page 7, line 28; figures 9-13	2,6-8

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

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27/11/1998

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# INTERNATIONAL SEARCH REPORT

## Information on patent family members

International Application No

PCT/US 98/16100

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 5381782	A 17-01-1995	WO	9313704 A	22-07-1993
EP 0778039	A 11-06-1997	CA	2192045 A	08-06-1997
		JP	9294813 A	18-11-1997
FR 2713492	A 16-06-1995	NONE		